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TITLE: LOW PRESSURE VAPOR GROWTH EQUIPMENT

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INVENTOR-INFORMATION:
NAME
MIYAZAKI, KAZUKI

ASSIGNEE-INFORMATION:

NAME	COUNTRY
NEC KYUSHU LTD	N/A

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ABSTRACT:

PROBLEM TO BE SOLVED: To reduce dispersion in the film thickness and film quality of wafers in respective positions in a reaction furnace of reduced pressure vapor growth equipment and to improve quality.

SOLUTION: This equipment has a double reaction furnace internal tube. The inside diameter of an outer internal tube 9a of the double reaction furnace internal tube is reduced, and the inside diameter of the internal tube in the region from a gas introducing part to an exhaust part is maintained at a fixed value, by which reaction pressure is kept constant. By replenishing and introducing a raw material gas between the internal tubes, reduction in the concentration of a reactant gas on the exhaust side can be inhibited without increasing the concentration on the raw material gas introducing side. By this method, film forming velocity in respective positions in the reaction furnace can be kept constant, and the uniformity of film thickness and film quality can be improved.

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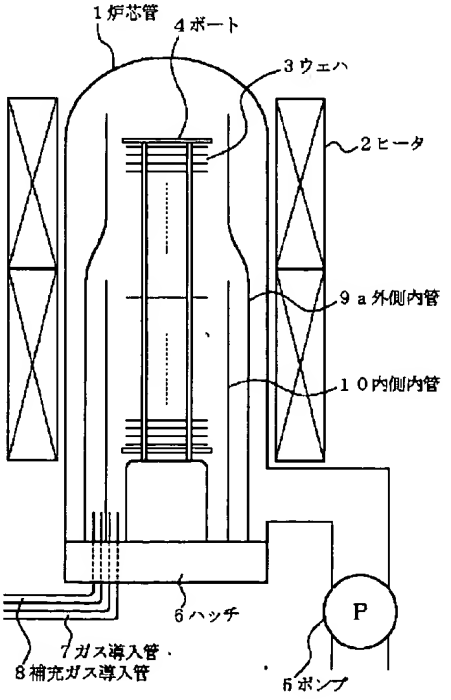
(71)出願人　000164450
九州日本電気株式会社
熊本県熊本市八幡一丁目１番１号
(72)発明者　宮▲崎▼　和樹
熊本県熊本市八幡一丁目１番一号　九州日本電気株式会社内
(74)代理人　弁理士　京本　直樹　（外２名）

(54)【発明の名称】　減圧気相成長装置

(57)【要約】
【課題】減圧気相成長装置において、反応炉内の各位置におけるウエハの膜厚や膜質のばらつきを低減し、品質の向上を図る。
【解決手段】二重の反応炉内管を有し、この二重の反応炉内管の外側内管の内径を絞り、ガス導入部から排気部までの内管内径を一定に保つことにより、反応圧力を一定に保つ。その内管の間に原料ガスを補充して導入することにより、原料ガス導入側の濃度を上げずに、排気側の反応ガス濃度の低下を抑えることができる。これにより、反応炉内の各位置における成膜速度を一定に保つことが可能となり、膜厚や膜質の均一性が向上する。



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【特許請求の範囲】

【請求項１】　ウエハを搭載したボートを炉芯管内に装填し、ボートと炉芯管との間にボートを囲む二重管構造の内管を設置し、炉芯管内を減圧するとともに、反応ガスを二重管内に導入してウエハに膜成長を行う減圧気相成長装置において、前記二重管の外側内管を延長し、延長部をテーパ状に絞り込んでその先を細くし、内管は一端側が二重管構造であり、他端側が単管構造であることを特徴とする減圧気相成長装置。

【請求項２】　前記二重管の外側内管を細くした部分の内径を、内側内管の内径と等しくし、前記ウエハと内管内径との間隔を一定としたことを特徴とする請求項１記載の減圧気相成長装置。

【請求項３】　前記二重管の内側内管内には主たる反応ガスを導入し、内側内管と外側内管との間隙には、反応で消費されたガスを補うための補充反応ガスを導入することを特徴とする請求項１記載の減圧気相成長装置。

【請求項４】　前記主たる反応ガスと補充反応ガスとを、前記テーパ部で合流させることを特徴とする請求項１記載の減圧気相成長装置。

【請求項５】　前記テーパ部は前記ボート長のほぼ中央部に対向する位置に形成したことを特徴とする請求項１記載の減圧気相成長装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、半導体製造措置に関わり、特に、半導体基板（ウエハ）に原料ガスに応じた膜を気相成長させる減圧気相成長装置に関する。

【０００２】

【従来の技術】従来より、半導体の製造においては、電極形成やマスクを用いた膜形成等、多くの成膜工程があり、減圧気相成長装置が用いられている。図２は、従来の縦型減圧気相成長装置の断面図である。

【０００３】図２の縦型減圧気相成長装置は、例えば、特開平５－１３６０５９号公報に示されるように、炉芯管１と、炉芯管１内を所望の温度に保つためのヒータ２と、ウエハ３を搭載するボート４と、炉芯管１内を減圧状態にし、反応ガスの排気を行うポンプ５と、炉芯管１の密閉を行うハッチ６と、炉芯管１の内部に原料ガスを導入するガス導入管７と、導入した原料ガスを二分して一部を排気側に近い反応部へ流すようにした二重管構造の外側内管９及び内側内管１０を有している。外側内管９は、内側内管１０よりも長く形成されている。

【０００４】従来の、縦型減圧気相成長装置におけるウエハ上への所望の成膜は、以下のように行う。まず、ヒータ２により所望の温度に保たれた炉芯管１内に、ウエハ３を搭載したボート４を挿入し、ハッチ６により炉芯管１を密閉し、ポンプ５により炉芯管１内を所望の圧力に減圧し、その後、原料ガスを導入管７より供給し、ガス濃度が低下する排気側に位置するウエハ３上には、外

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側内管９と内側内管１０との間隙を通った比較的高濃度の原料ガスを導入して成膜を行う。未反応の原料ガスは、ポンプ５により排気され、炉芯管１外へ排出されるようになっている。

【０００５】

【発明が解決しようとする課題】従来の縦型減圧気相成長装置では、原料ガスを炉芯管１の下端のみから導入するため、炉芯管１内のガスの流れは、ガス導入部から排気側に向けて常に一方向となっている。導入された原料ガスは、ウエハ３及び内側内管１０の内壁に成膜し、排気側へガスが移動するに従い、そのガス濃度が低下する。そのために、ガス導入部に比べガス排気側に近い部分でのウエハ上の成膜速度が低下し、同一バッチ内で、膜厚差や不純物の濃度差が生じるという問題点があった。

【０００６】そのような弊害を回避するために、ヒータ２を複数のゾーンに分割し、ガス濃度が低い排気側の温度を上げることによって反応を促進させ、あるいは、ガス濃度が高いガス導入側の温度を下げることによって反応を押さえ、同一バッチ内の膜厚均一性、及び不純物濃度均一性を一定に保つ方法がある。

【０００７】また、図２に示したように、ガス導入部近傍に置かれたウエハ３にのみ成膜しないように、二重管で区切られた外側内管９と内側内管１０との間に原料ガスを流すことにより、排気側の原料ガス濃度を高めて反応を促進させ、同一バッチ内の膜厚均一性を向上させる方法がある。

【０００８】しかし、この図２の装置では、内側内管１０がとぎれる部分から、内管は二重管ではなくなり外側内管９のみとなるため、内管径が急激に拡大し、炉芯管１の内圧が下がるという傾向がある。このため、内側内管１０がとぎれる部分での原料ガスの分圧が下がり、膜厚あるいは不純物濃度が低下するという問題があった。

【０００９】本発明は、同一バッチ内のウエハ上に成膜される膜厚や不純物濃度、または膜質構造を均一にし、製品での製造ばらつきを低減することを目的とする。

【００１０】

【課題を解決するための手段】本発明は、ウエハを搭載したボートを炉芯管内に装填し、ボートと炉芯管との間にボートを囲む二重管構造の内管を設置し、炉芯管内を減圧するとともに、反応ガスを二重管内に導入してウエハに膜成長を行う減圧気相成長装置において、前記二重管の外側内管を延長し、延長部をテーパ状に絞り込んでその先を細くし、内管は一端側が二重管構造であり、他端側が単管構造であることを特徴とする減圧気相成長装置である。

【００１１】

【発明の実施の形態】次に、本発明の実施の形態を図面を用いて説明する。図１は本発明の実施の形態を示す縦型減圧気相成長装置の断面図であり、成長する膜をｉｎ

－ｓｉｔｕＰドープＳｉを例にとって説明する。

【００１２】反応管となる炉芯管１と、炉芯管１内を所望の温度（例えば５００～５５０℃）に保つためのヒータ２と、ウエハ３を搭載するボート４と、炉芯管１内を減圧状態、例えば０．５～５Ｔｏｒｒまでにガスの排気を行うポンプ５と、炉芯管１の密閉を行うハッチ６と、炉芯管１の内部に原料ガス、例えばＳｉＨ４とＰＨ３を導入するガス導入管７と、排気側で反応により低下した原料ガス、例えばＰＨ３を補うための補充ガス導入管８と、これら原料ガスを、反応を押さえながら排気側反応部へ導入する外側内管９ａ及び内側内管１０からなる二重管構造を有している。

【００１３】この外側内管９ａは、上部を内側内管１０よりも延長し、延長部は内側内管１０と同一の内径となるように、上部の管径をテーパ状に絞って細くし、単管構造としてある。細くした部分の内径は、内側内管１０の内径と等しくする。また、外側内管９ａと内側内管１０との隙間は、外側内管９ａと内側内管１０との間に逆拡散が起きない程度であればよく、例えば、３００ｍｍの内側内管内径に対し、５０ｍｍ程度でよい。また、内側内管１０の長さは、ボート４の中程までとし、外側内管９ａの長さは、ボート４の頂部よりやや長くする。

【００１４】次に、本発明の動作について、図１を用いて説明する。本発明の縦型減圧気相成長装置では、原料ガス、例えばＳｉＨ４とＰＨ３を炉芯管１の下端から導入し、排気側へと流す構造であり、炉芯管１内のガスの流れは、ガス導入側から排気側へ向けて常に一方向となっている。導入された原料ガスであるＳｉＨ４およびＰＨ３は、ウエハ３及び内側内管１０の内壁に成膜し、排気側へガスが移動するに従いガス濃度が低下する。ｉｎ－ｓｉｔｕＰドープＳｉの場合、Ｐ濃度の炉内均一性が１０～２０％まで低下する。

【００１５】そこで、本発明は、原料ガスの導入部近傍にあるウエハ３の成膜を押さえるために、内管を二重管にし、区切られた外側内管９ａと内側内管１０との間に原料ガス、例えばＰＨ３を流すことにより、原料ガス濃度の低下を補う。そのために、本発明では、内側内管１０がとぎれる部分から、外側内管９ａの管径をテーパ状に絞ることにより、この絞り部から原料ガスを合流させ、炉芯管１内の排気コンダクタンスを一定に保ち、反応炉内の反応ガスの流量及び圧力を一定に保つことが可能となる。

【００１６】この結果、本発明の実施の形態においては、炉芯管内各位置におけるウエハの膜厚及び不純物濃度を含めた膜質の均一性が５％まで向上した。以上、本発明を縦型減圧気相成長装置について述べてきたが、横型減圧気相成長装置にも適用できることはもちろんである。

【００１７】

【発明の効果】本発明の第１の効果は、原料ガス導入側と排気側との、ウエハの成長膜厚及び不純物濃度などの膜質を均一にし、製造ばらつきを低減することができることである。その理由は、原料ガス導入側と排気側との、反応ガス濃度と反応圧力のばらつきを低減し、反応速度を均一にすることを可能にしたからである。

【００１８】第２の効果は、製品の信頼性のばらつきを低減することができることである。その理由は、第１の効果で説明したように、膜厚、膜質を均一にすることを可能にしたからである。

【図面の簡単な説明】

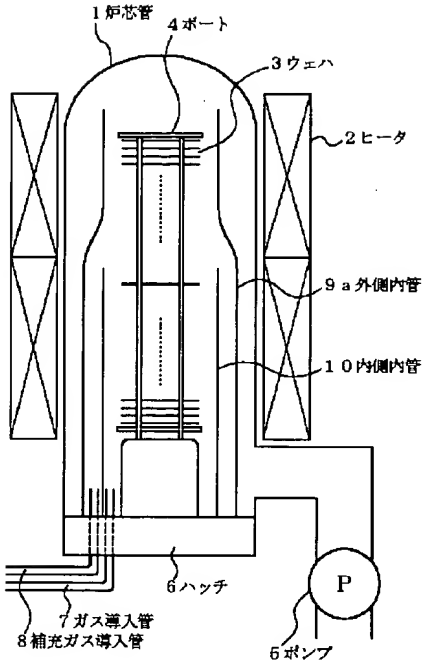
【図１】本発明の実施の形態を示す縦型減圧気相成長装置の断面図である。

【図２】従来の縦型減圧気相成長装置の断面図である。

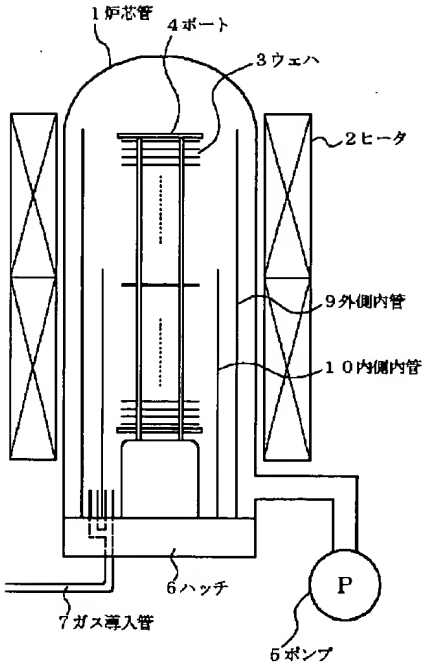
【符号の説明】

１　炉芯管
２　ヒータ
３　ウエハ
４　ボート
５　ポンプ
６　ハッチ
７　ガス導入管
８　補充ガス導入管
９、９ａ　外側内管
１０　内側内管

【図１】


１炉芯管
４ポート
３ウェハ
２ヒータ
９ａ外側内管
１０内側内管
６ハッチ
７ガス導入管
８補充ガス導入管
５ポンプ
P

【図２】


１炉芯管
４ポート
３ウェハ
２ヒータ
９外側内管
１０内側内管
６ハッチ
７ガス導入管
５ポンプ
P

* NOTICES *

CLAIMS

[Claim(s)]

[Claim 1] While loading with the boat carrying the wafer into a reactor core tube, installing the inner tube of the double-pipe structure which surrounds a boat between a boat and a reactor core tube and decompressing the inside of a reactor core tube It is reduced pressure vapor-growth equipment which extends the outside inner tube of the aforementioned double pipe, narrows down an extension in the shape of a taper in the reduced pressure vapor-growth equipment which introduces reactant gas within double and performs film growth to a wafer, makes the point thin, and is characterized by for the end side of an inner tube being double-pipe structure, and an other end side being single pipe structure.

[Claim 2] Reduced pressure vapor-growth equipment according to claim 1 characterized by having made equal to the bore of an inside inner tube the bore of the portion which made thin the outside inner tube of the aforementioned double pipe, and seting constant the interval of the aforementioned wafer and an inner-tube bore.

[Claim 3] Reduced pressure vapor-growth equipment according to claim 1 characterized by introducing main reactant gas in the inside inner tube of the aforementioned double pipe, and introducing the anaplerotic reaction gas for compensating the gap of an inside inner tube and an outside inner tube with the gas consumed at the reaction.

[Claim 4] Reduced pressure vapor-growth equipment according to claim 1 characterized by making the aforementioned main slack reactant gas and anaplerotic reaction gas join in the aforementioned taper section.

[Claim 5] The aforementioned taper section is reduced pressure vapor-growth equipment according to claim 1 characterized by forming in the position of the aforementioned boat length which counters a center section mostly.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention is concerned with a semiconductor manufacture measure, and relates to the reduced pressure vapor-growth equipment which carries out the vapor growth of the film according to material gas to a semiconductor substrate (wafer) especially.
[0002]
[Description of the Prior Art] Before, in manufacture of a semiconductor, there are many membrane formation processes, such as electrode formation and film formation using the mask, and reduced pressure vapor-growth equipment is used. Drawing 2 is the cross section of conventional vertical-mold reduced pressure vapor-growth equipment.
[0003] As the vertical-mold reduced pressure vapor-growth equipment of drawing 2 is shown in JP,5-136059,A A reactor core tube 1, the heater 2 for maintaining the inside of a reactor core tube 1 at desired temperature, and the boat 4 carrying a wafer 3, The pump 5 which changes the inside of a reactor core tube 1 into a reduced pressure state, and exhausts reactant gas, and the hatch 6 which performs sealing of a reactor core tube 1, It has the gas introduction pipe 7 which introduces material gas into the interior of a reactor core tube 1, and the outside inner tube 9 and the inside inner tube 10 of double-pipe structure which bisect the introduced material gas and passed the part to the reaction section near an exhaust side. The outside inner tube 9 is formed for a long time than the inside inner tube 10.
[0004] Membrane formation of the request to up to the wafer in conventional vertical-mold reduced pressure vapor-growth equipment is performed as follows. First, the boat 4 which carried the wafer 3 in the reactor core tube 1 maintained at desired temperature at the heater 2 is inserted. Seal a reactor core tube 1 by the hatch 6, and the inside of a reactor core tube 1 is decompressed to a desired pressure with a pump 5. Then, material gas is supplied from the introductory pipe 7, and membranes are formed by introducing the comparatively high-concentration material gas passing through the gap of the outside inner tube 9 and the inside inner tube 10 on the wafer 3 located in the exhaust side to which gas concentration falls. Unreacted material gas is exhausted with a pump 5, and is discharged out of a reactor core tube 1.
[0005]
[Problem(s) to be Solved by the Invention] With conventional vertical-mold reduced pressure vapor-growth equipment, in order to introduce material gas only from the soffit of a reactor core tube 1, on the other hand, the flow of the gas in a reactor core tube 1 always serves as Mukai from gas induction towards the exhaust side. The gas concentration falls as the introduced material gas forms membranes to the wall of a wafer 3 and the inside inner tube 10 and gas moves to an exhaust side. Therefore, compared with gas induction, the membrane formation speed on the wafer in the portion near a flueing side fell, and there was a trouble that a thickness difference and the concentration difference of an impurity arose, within the same batch.
[0006] In order to avoid such evil, when a heater 2 is divided into two or more zones, a reaction is promoted when gas concentration raises the temperature of a low exhaust side, or gas concentration lowers the temperature by the side of high gas introduction, a reaction is pressed down and there is the method of keeping constant the thickness homogeneity and high-impurity-concentration homogeneity in the same batch.
[0007] Moreover, as shown in drawing 2 , by passing material gas between the outside inner tubes 9 and the inside inner tubes 10 which were divided by the double pipe, the material gas concentration of an exhaust side is raised, a reaction is promoted, and there is a method of raising the thickness homogeneity in the same batch so that membranes may not be formed only to the wafer 3 placed near the gas induction.
[0008] However, with the equipment of this drawing 2 , since an inner tube is no longer a double pipe and turns into only the outside inner tube 9 from the portion into which the inside inner tube 10 is disrupted, the diameter of an inner tube is expanded rapidly and there is an inclination for the internal pressure of a reactor core tube 1 to fall. For this reason, the partial pressure of the material gas in the portion into which the inside inner tube 10 is disrupted fell, and there was a problem that thickness or high impurity concentration fell.
[0009] this invention makes uniform thickness formed on the wafer in the same batch, high impurity concentration, or membraneous structure, and aims at reducing manufacture dispersion in a product.
[0010]
[Means for Solving the Problem] While this invention loads with the boat carrying the wafer into a reactor core tube, installs the inner tube of the double-pipe structure which surrounds a boat between a boat and a reactor core tube and decompresses the inside of a reactor core tube In the reduced pressure vapor-growth equipment which introduces reactant gas within double and

performs film growth to a wafer The outside inner tube of the aforementioned double pipe is extended, an extension is narrowed down in the shape of a taper, the point is made thin, and an inner tube is reduced pressure vapor-growth equipment characterized by for an end side being double-pipe structure and an other end side being single pipe structure.

[0011]

[Embodiments of the Invention] Next, the gestalt of operation of this invention is explained using a drawing. Drawing 1 is the cross section of the vertical-mold reduced pressure vapor-growth equipment in which the gestalt of operation of this invention is shown, and explains the film which grows taking the case of the in-situP dope Si.

[0012] The reactor core tube 1 used as a coil, and the heater 2 for maintaining the inside of a reactor core tube 1 at desired temperature (for example, 500-550 degrees C), The boat 4 carrying a wafer 3, and the pump 5 which exhausts gas for the inside of a reactor core tube 1 by the reduced pressure state, for example, 0.5 - 5Torr The hatch 6 which seals a reactor core tube 1, and the gas introduction pipe 7 which introduces material gas, SiH4 and PH3, into the interior of a reactor core tube 1, [for example,] It has the double-pipe structure which consists of a supplement gas introduction pipe 8 for compensating with an exhaust side the material gas 3 which fell by the reaction, for example, PH, and outside inner-tube 9a which introduces these material gas to the exhaust side reaction section while pressing down a reaction and the inside inner tube 10.

[0013] This outside inner-tube 9a extends the upper part rather than the inside inner tube 10, it extracts a upside tube diameter in the shape of a taper, makes it thin, and has made it single pipe structure so that an extension may serve as the same bore as the inside inner tube 10. The bore of the portion made thin is made equal to the bore of the inside inner tube 10. Moreover, the crevice between outside inner-tube 9a and the inside inner tube 10 is [that what is necessary is just the grade in which back-diffusion of gas does not occur between outside inner-tube 9a and the inside inner tube 10] good to the inside inner-tube bore of 300mm at about 50mm. Moreover, the length of the inside inner tube 10 is carried out to to the middle of a boat 4, and the length of outside inner-tube 9a is made a little longer than the crowning of a boat 4.

[0014] Next, operation of this invention is explained using drawing 1 . With the vertical-mold reduced pressure vapor-growth equipment of this invention, material gas, SiH4 and PH3, is introduced from the soffit of a reactor core tube 1, it is the structure passed to an exhaust side, and, on the other hand, the flow of the gas in a reactor core tube 1 always serves as Mukai from the gas introduction side towards the exhaust side. [for example,] SiH4 and PH3 which are introduced material gas form membranes to the wall of a wafer 3 and the inside inner tube 10, and gas concentration falls as gas moves to an exhaust side. In the case of the in-situP dope Si, the homogeneity in a furnace of P concentration falls to 10 - 20%.

[0015] Then, this invention is compensated with the fall of material gas concentration by making an inner tube into a double pipe and passing material gas 3, for example, PH, between outside inner-tube 9a and the inside inner tubes 10 which were divided, in order to press down membrane formation of the wafer 3 near the induction of material gas. Therefore, in this invention, it becomes possible to make material gas join from this converging section by extracting the tube diameter of outside inner-tube 9a from the portion into which the inside inner tube 10 is disrupted in the shape of a taper, to keep constant the exhaust air conductance in a reactor core tube 1, and to keep constant the flow rate and pressure of reactant gas in a reactor.

[0016] Consequently, in the gestalt of operation of this invention, the membraneous homogeneity including the thickness and high impurity concentration of a wafer in each [in a reactor core tube] position improved to 5%. As mentioned above, although this invention has been described about vertical-mold reduced pressure vapor-growth equipment, of course, it is applicable also to horizontal-type reduced pressure vapor-growth equipment.

[0017]

[Effect of the Invention] The 1st effect of this invention is being able to make uniform membraneous qualities, such as growth thickness of a wafer with an exhaust side, and high impurity concentration, a material gas introduction side, and being able to reduce manufacture dispersion. The reason is the shell which made it possible to reduce dispersion in reactant gas concentration with an exhaust side, and reaction pressure a material gas introduction side, and to make a reaction rate uniform.

[0018] The 2nd effect is being able to reduce dispersion in the reliability of a product. The reason is thickness and the shell which made it possible to make membraneous quality uniform, as the 1st effect explained.

[Translation done.]